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FORESTRY-RELATED IMPACTS OF 2, 4, 5-T IN OREGON

Walter H. Knapp, Robert D. Greaves & Jerome J. Chetock

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and Jerome J. Chetock

January 30, 1979

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ABSTRACT

This report is designed to estimate current and potential use levels of 2,4,5-T for silvicultural operations; determine alternatives to 2,4,5-T; evaluate impacts on future timber supply if 2,4,5-T is unavailable; compare the economic efficiency of using versus not using 2,4,5-T for forest management; indicate the potential changes in silviculture budgets; and estimate employment impacts if 2,4,5-T is unavailable.

The general approach to assessing alternative management practices and their cost and yield impacts was based primarily on a survey of experienced silviculturists within each of four vegetative subregions in Oregon. These subregions included northwestern Oregon (salmonberry-alder type); southwestern Oregon (tanoak-madrone and tanoak-chinquapin types); Cascade Range (vine maple-ceanothus type); and eastern Oregon (ceanothus and manzanita types).

During 1976 and 1977, 2,4,5-T was used on about 88,000 acres each year for forestry purposes in Oregon, roughly one-third of the potential level.

If 2,4,5-T is unavailable for forestry use in Oregon, a wide range of substitute practices would be used in the four major areas of the State. These practices generally result in increased silvicultural costs ranging from -3 percent to +67 percent of present levels. They are less efficient economically than the use of 2,4,5-T on potential use areas.

The economic impact of managing Oregon's forests without 2,4,5-T would be felt now and in the future in terms of both increased management costs and decreased revenues (i.e. yields). The state-wide impact in perpetuity of these consequences can be measured as the difference in the present net worth of the land when managed with and without 2,4,5-T. Management of Oregon's forests with 2,4,5-T could provide from $383 million (at current application rates) to $1.10 billion (at potential rates) greater present net worth than management without 2,4,5-T.

Furthermore, use of these alternatives could potentially result in an 11 percent reduction in timber yield--a current annual loss of 936 million board feet. The employment impacts of this reduction are estimated to be about 20,000 jobs, including both primary and secondary employment.

These impacts would be most heavily felt in western Oregon. In this area, not only are vegetative types more dependent upon the use of herbicides, but timber supplies are also critically short (Beuter et al. 1976). If 2,4,5-T is not available, projections in this study indicate that current harvest levels in this area and the State as a whole cannot be maintained.

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FORESTRY-RELATED IMPACTS OF 2,4,5-T IN OREGON

by

Walter H. Knapp, Robert D. Greaves,
and Jerome J. Chetock[1/]

INTRODUCTION

This report assesses the effects of management with and without the herbicide 2,4,5-T on timber production, economic efficiency, employment, and related aspects for the State of Oregon. The assessment focuses on the four major geographic areas in Oregon: northwestern, southwestern, Cascade Range, and eastern. A more detailed case study for southwestern Oregon compares the economic efficiency among alternatives within this area (Appendix A).

Recent timber supply projections for western Oregon forecast a 22 percent decline in timber harvest by the year 2000 unless the

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[1/]Respectively, Silviculturist, USDA Forest Service, Region 6, Portland, Oregon; Forest Resource Analyst, and Silviculturist, Oregon State Dept. of Forestry, Salem, Oregon

intensity of forest management is increased (Beuter et al. 1976). Herbicides have been an integral part of intensive forest management. In particular, the herbicide 2,4,5-T has been regarded as an effective tool for vegetation management within many forest types in Oregon.

The toxicity of 2,4,5-T and the hazards associated with its use have been studied with increasing intensity. In reviewing the chemical for reregistration, the United States Environmental Protection Agency (EPA) found that products containing this chemical exceeded the risk criteria relating to toxic effects specified in federal regulations. Thus, the EPA initiated a review process, a Rebuttable Presumption Against Registration (RPAR), to determine the relative risks and benefits derived from using this chemical.

This assessment in Oregon was undertaken to provide detailed information regarding the benefits of using 2,4,5-T in a key forestry state. This effort was conducted by representatives from the United States Forest Service, the Oregon State Department of Forestry, forest industry, and the Oregon State University School of Forestry.

The assessment was designed to:

* Estimate current and potential use levels of 2,4,5-T for silvicultural operations in Oregon.

* Determine alternatives to 2,4,5-T.

* Evaluate impacts on future timber supply projections if 2,4,5-T is not available for use.

* Compare the economic efficiency of forest management with and without 2,4,5-T.

* Indicate the potential changes in silviculture budgets.

* Estimate employment impacts if 2,4,5-T is not available for use.

PROCEDURE

The assessment of alternatives to the use of 2,4,5-T, including their cost and yield impacts, was based primarily on a survey of experienced silviculturists within each of four vegetative subregions in Oregon. The basic study procedure is shown in figure 1; additional details for the key steps follow.

GEOGRAPHIC AREAS

The herbicide 2,4,5-T has been used throughout the State in a wide variety of plant communities. To simplify the analysis, Oregon was divided into four general areas (figure 2) where alternatives to 2,4,5-T vary significantly because of major vegetative differences.[1/] The areas are northwestern (salmonberry-alder type); southwestern (tanoak-madrone and tanoak-chinquapin types); Cascade Range (vine maple-ceanothus type); and eastern (ceanothus and manzanita types). Divisions for analysis were based on political boundaries that approximated these vegetative zones in order to correlate with other data sources.

[1/] Approach based on similar technique developed by the U.S. Forest Service for their 1978 Herbicide Environmental Statement. (USDA FS 1978)

SURVEY

Within each geographic area a survey of selected silviculturists was taken, representing a cross-section of owner classes and experiences. The following information was derived through the initial survey and followup:

* Potential use of 2,4,5-T for silvicultural purposes.

* Alternative vegetation control methods.

* Yield impacts of alternatives.

SELECTION OF ALTERNATIVES

To evaluate the economic and silvicultural impacts of not having 2,4,5-T for management, a representative set of management practices with 2,4,5-T was defined for comparison within each region. Typical practices for site preparation and rehabilitation were based on "Suggested Site Preparation Methods" in Stewart (1978).

To simplify analysis, only one set of representative management practices was selected for all owner classes. Many industrial forest owners will manage their lands more intensively and many small woodland owners less intensively than the selected typical management level.

2,4,5-T MODEL DEVELOPMENT
FLOW DIAGRAM

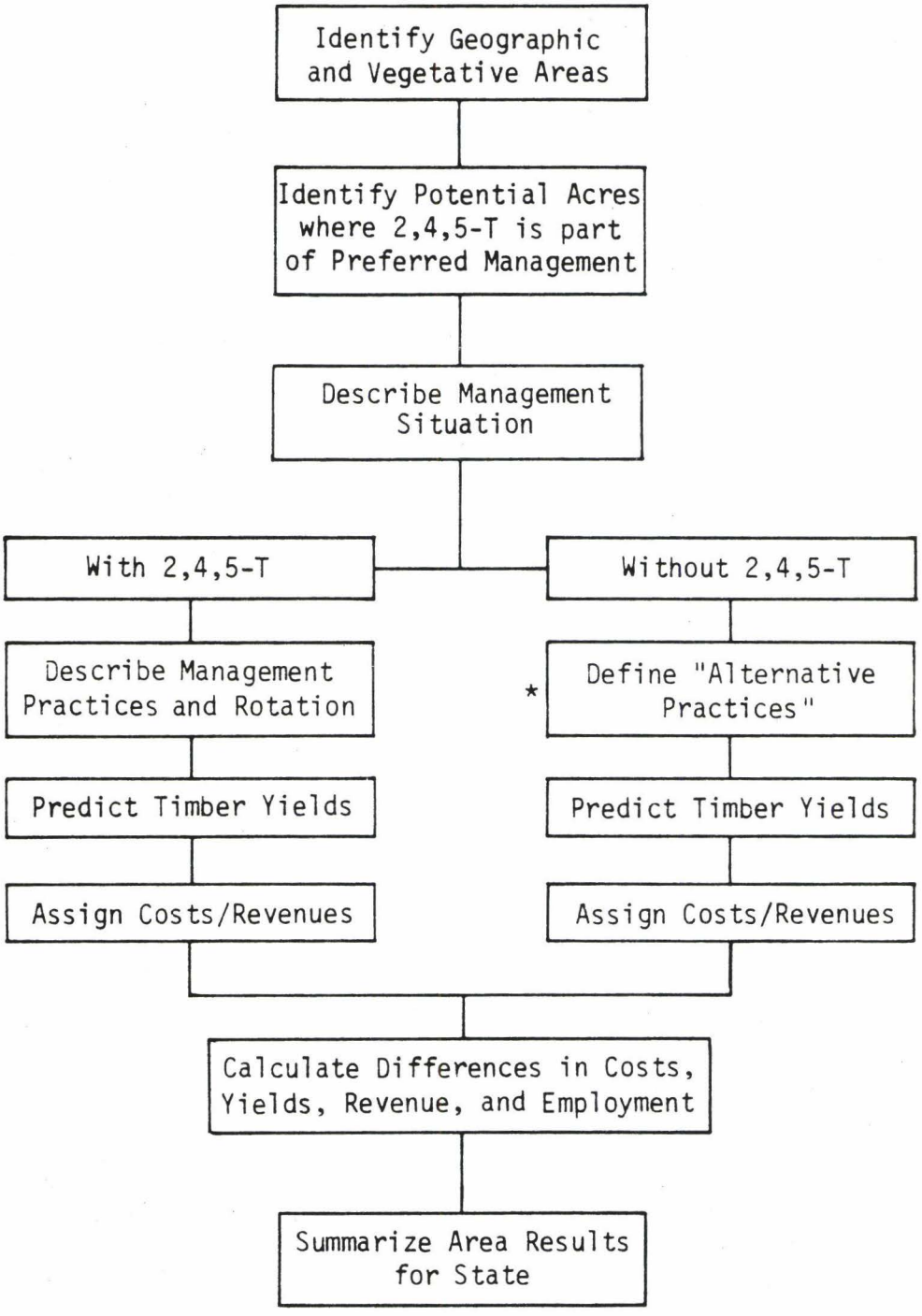

Figure 1--Flow diagram for assessing forestry-related impacts of 2,4,5-T in Oregon.

*Information derived from survey of silviculturists.

FIGURE 2. MAP OF OREGON SHOWING FOUR MAJOR GEOGRAPHIC AREAS.

The most prevalent alternatives to 2,4,5-T for silvicultural purposes were derived from survey results. Alternatives were not restricted by cost or yield assumptions, but tend to reflect the next choice management practices and the area to which these practices apply. Alternative chemicals were considered if registered and applicable for use.

Effect of Owner Class on Selection of Alternatives

Management intensity and selection of alternative treatments will vary among and within owner classes. Evaluating these differences within the model was beyond the scope of this project. Thus, differences in cost (silvicultural budget), yield, and subsequent projections for timber supply and employment represent an average approximation of the overall impact of losing 2,4,5-T as a silvicultural tool.

Actual impacts among and within owner classes may be higher or lower depending on owner objectives, individual management or funding constraints, productive quality of forest land, and management intensity. For example, forest industry lands in western Oregon are predominantly medium site or high site class (41 and 47 percent of total in owner class, respectively)(Beuter et al. 1976). Brush problems on these lands will generally be more severe than on low site class lands. When coupled with the fact that industry manages its lands on shorter rotations than other owner classes, selection of alternatives to 2,4,5-T that are less effective for brush control will cause a relatively larger decrease in yield on industry land. In most cases, industry managers will choose the most economically efficient alternative available. Some industry owners may choose not to manage their lands when economically viable alternatives are not available.

Small nonindustrial private forest owners manage their lands for a variety of objectives--not all economically motivated. Those who do manage for commercial timber would tend to have funding constraints that limit the application of more costly alternatives to 2,4,5-T. Losing 2,4,5-T in this owner class may result in changes in ownership or objectives (e.g., conversion to nonforest or noncommodity uses).

State and federal public agencies may have labor-intensive alternatives available on some lands where alternatives such as slashing or hand-clearing of brush are effective. The major limitations to increased use of manual brush control are the high treatment costs, lack of manpower, predominance of resprouting species, and safety considerations.

In all cases, choice of an effective alternative to 2,4,5-T depends on: ground cover, physical factors such as topography and soil type, site preparation or release requirements, available manpower and equipment, external constraints such as regulations and objectives, environmental impacts, and cost (Stewart 1978). Each owner or land manager has a unique combination of these variables for each site that needs treatment. The impact of losing 2,4,5-T as a silvicultural tool will depend on these variables and ultimately on the alternative(s) selected.

If 2,4,5-T were unavailable for forestry use in Oregon, that portion of site preparation, rehabilitation, and release currently requiring 2,4,5-T would have to be accomplished by different means. The most likely silvicultural substitutes for 2,4,5-T are identified in Tables 3, 6, 8, and 10. Although no presently registered herbicide can fully substitute for 2,4,5-T as a broad spectrum silvicultural tool, other chemicals would be utilized on some sites in the absence of 2,4,5-T.

Substitute herbicides for site preparation, rehabilitation, and release in Oregon include 2,4-D, Silvex, Amitrole, glyphosate (Roundup), and Fosamine ammonium (Krenite). In addition, 2,4-DP (Dichlorprop), Tordon 101 (Picloram and 2,4-D), Dicamba, and Dinoseb are partial substitutes for site preparation and rehabilitation. The degree of actual replacement for 2,4,5-T varies with the specific herbicide and vegetative species (Stewart 1978, USDA ARS, Undated, and Newton, unpublished). 1/ No single presently registered herbicide can fully substitute for 2,4,5-T as a broad spectrum silvicultural tool.

PREDICTION OF TIMBER YIELDS

With 2,4,5-T

Potential timber production with 2,4,5-T was predicted in western Oregon from DFIT (Douglas-fir Interim Tables) computer simulations (Bruce et al. 1977) using the average site productivity summarized from U.S. Forest Service survey data.2/ These simulations reflect the anticipated development of an average future stand of timber managed as described in the alternatives for each region. Timber yields for an average site in eastern Oregon had been developed in an earlier analysis (Sassaman et al. 1977). Stand age for each silvicultural operation was based on standard practices within each region without regard to ownership variations. The assumed rotation ages were: northwestern, 65 years; southwestern, 85 years; Cascade Range, 75 years; and eastern, 120 years. Rotation ages were based on averages for industry and federal lands, given an assumed level of management.

1/Newton, M. 1978. Chart on susceptibility of forest species to herbicides. Unpublished data on file at Oregon State Univ. Forest Research Laboratory, Corvallis, Oregon.

2/Data on file, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Without 2,4,5-T

Potential yield decreases without 2,4,5-T were estimated by survey respondents. DFIT computer simulations for western Oregon were modified to be consistent with these estimates. Eastern Oregon yield predictions were also reduced consistent with the estimates from the survey of silviculturists. These yield impacts were calculated using weighted averages. A sample derivation of overall yield effects is displayed in Appendix B.

ECONOMICS

Costs

The cost for each management practice was derived from recent reports (OSDF 1977, USDA FS 1978; Bernstein and Brown 1977). Costs reflect statewide averages for all owner classes.

Revenues

Revenues for commercial thinnings and final harvests for western Oregon start at the U.S. Forest Service's 1980 Resources Planning Act Timber Assessment stumpage value of $124 per cunit[1/]. Eastern Oregon revenues were reduced by 33 percent to reflect recent stumpage value differences. Thinning revenues were reduced to 75 percent of the final harvest stumpage value.

Economic Efficiency

The economic efficiency of management with and without 2,4,5-T was evaluated using MULTIPLOY (Row 1976), a computer-assisted economic analysis. Present net worth and benefit-cost ratios were calculated from cost and yield data for the alternatives. Treatment costs were

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[1/] A cunit equals 100 cubic feet or approximately 500 board feet for the assessment area.

assumed to be constant in real terms, and timber values were increased at 2.5 percent annually in real terms, based on trend analysis. Because real prices are used in the analysis, the most relevant interest rate for interpreting the results is a real rate which is below the current market rate. In this report an alternative investment rate of 6 5/8 percent was used as presently recommended by the Water Resources Council (WRC) for long-term investments on federal lands. Rates of 4, 8, and 10 percent are also analyzed for comparison.

Employment

Changes in yield will affect both direct and indirect forest industry employment.[1/] Multipliers of 7.51 jobs per million board feet of timber processed for direct employment and 15.02 jobs per million board feet for indirect (secondary) employment were based on recent averages for the State of Oregon.[2/] Employment increases resulting from alternatives to 2,4,5-T that require more intensive labor were not considered. For a discussion of these effects, refer to the Final Environmental Statement for Vegetation Management With Herbicides for Region 6 of the U.S. Forest Service (USDA FS 1978).

CURRENT AND POTENTIAL USE OF 2,4,5-T

Intensive forest management is an integrated series of practices designed to establish, maintain, and utilize stands of commercial tree species in an efficient and economical manner. Site preparation, conifer release, and rehabilitation of underproductive lands are

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[1/] Direct employment includes those jobs that are specifically a part of timber harvesting and processing. Indirect employment includes those additional jobs resulting from direct employment, from shops, restaurants, and the like. Synonyms: Primary employment and secondary employment.

[2/] Western Environmental Trade Association, Oregon TREE project, phase 1 data, October 1976, on file.

practices within this series which are commonly accomplished, at least in part, with 2,4,5-T. For a variety of reasons, not all commercial forest lands are presently managed according to their potential for timber production. Nevertheless, the potential use of 2,4,5-T was defined as that level of usage which would accompany intensive management on commercial forest land where 2,4,5-T would normally be a part of the preferred management. For example, survey respondents estimated that 2,4,5-T is part of preferred management on 75 percent of the commercial forest lands in northwestern Oregon. The potential use of 2,4,5-T for all silvicultural purposes is shown in table 1. In 1976 and 1977, 2,4,5-T was used on approximately 88,000 acres per year, roughly one-third of the potential level. Details are included in Appendix C.

DESCRIPTION OF ALTERNATIVES

Vegetation management is frequently accomplished with silvicultural tools other than 2,4,5-T, or by combining another method with 2,4,5-T. Mechanical methods, fire, other herbicides, and hand slashing of vegetation are viable alternatives to 2,4,5-T in some specific situations. Although alternatives are available and are used where appropriate, 2,4,5-T currently remains the preferred treatment on a significant part of the commercial forest in Oregon.

Table 2 shows the potential use of 2,4,5-T for rehabilitation of forest lands presently nonstocked or understocked with conifers. Unless these areas are treated, they are not likely to produce satisfactory stands of commercial species within a reasonable time span.

NORTHWESTERN OREGON

The typical management for northwestern Oregon involves the use of 2,4,5-T on 75 percent of the commercial forest land. Thirty percent of site preparation in this area is done with 2,4,5-T in combination with a slash disposal fire. Rehabilitation of underproductive forest lands uses 2,4,5-T in combination with fire and hand slashing on 50

Table 1--Potential use of 2,4,5-T for silvicultural practices in Oregon

Silvicultural Practice	Geographic Area				
	Northwestern	Southwestern	Cascades	Eastern	State Total
	--Thousands of acres (percent of CFL 1/ in geographic area)--				
Rehabilitation and Release With 2,4,5-T 2/	255(9%)	129(2%)	199(4%)	incidental	583(2%)
Site Preparation and Release With 2,4,5-T 2/	569(20%)	894(15%)	319(7%)	incidental	1,782(8%)
Release Only With 2,4,5-T	1,329(46%)	3,574(58%)	1,808(39%)	1,944(19%)	8,655(36%)
Subtotal: All 2,4,5-T	2,153(75%)	4,597(75%)	2,326(50%)	1,944(19%)	11,020(46%)
No 2,4,5-T	718(25%)	1,532(25%)	2,325(50%)	8,287(81%)	12,862(54%)
TOTAL	2,871(100%)	6,129(100%)	4,651(100%)	10,231(100%)	23,882(100%)

1/CFL = commercial forest land.
2/Areas that require 2,4,5-T for site preparation or rehabilitation also require 2,4,5-T for release.

Table 2--Potential use of 2,4,5-T for rehabilitation in western Oregon[1/]

Treatment Description	Geographic Area		
	Northwestern	Southwestern	Cascades
	---Thousands of acres (percent of CFL in geographic area)---		
Rehabilitation with 2,4,5-T	255 (50%)	129 (45%)	199 (30%)
Rehabilitation without 2,4,5-T	255 (50%)	157 (55%)	463 (70%)
Total Rehabilitation	510 (100%)	286 (100%)	662 (100%)

[1/]The use of 2,4,5-T for rehabilitation in eastern Oregon is minor and is not included.

percent of this underproductive area. Two release operations are generally applied to forest plantations in northwestern Oregon, with 2,4,5-T being the preferred treatment on 75 percent of the area.

If 2,4,5-T were unavailable for forestry use in northwestern Oregon, the practices of site preparation, rehabilitation, and release would have to be accomplished by different means. The range of alternative treatments available include mechanical, other chemical, fire, hand slashing, no management, and combinations of these methods. The silvicultural alternatives to 2,4,5-T identified by survey respondents in northwestern Oregon are listed in table 3. The resulting alternative management is contrasted to the typical management in table 4. Note that the silvicultural cost--the sum of anticipated stand investments--is slightly lower without 2,4,5-T in northwestern Oregon. This decrease in costs occurs because (1) 15 percent of the time no release is done because no cost effective alternatives are available, and (2) alternatives to 2,4,5-T, though less effective, are only slightly more expensive.

Although these substitute practices decrease costs, they also directly impact timber yield. The analysis indicates that in northwestern Oregon, 39 cubic feet per acre per year would be lost if 2,4,5-T were unavailable--a reduction of 19 percent on areas that would normally use 2,4,5-T (table 11).

SOUTHWESTERN OREGON

Typical management for southwestern Oregon involves the use of 2,4,5-T on 75 percent of the commercial forest land. Twenty percent of site preparation in this area uses 2,4,5-T in conjunction with a slash disposal fire. Forty-five percent of the rehabilitation of nonmerchantable multistoried hardwood stands on steep slopes, prevalent in this area, involves combining 2,4,5-T with hand slashing and fire. Seventy-five percent of the forest plantations in southwestern Oregon are expected to require two release operations, both typically done with 2,4,5-T.

Table 3--Silvicultural substitutes for 2,4,5-T in northwestern Oregon

Silvicultural Substitutes for 2,4,5-T	Percent Replacement for 2,4,5-T	Percent 1/ Yield
Site Preparation		
Fire	30% 3/	90%
Other Chemical	15%	100%
Other Chemical and Fire	35%	100%
Clean Log Only 2/	20%	70%
Rehabilitation		
Other Chemical	35%	85%
Hand Slash, Other Chem., and Fire	50%	100%
No Rehabilitation	15%	10%
Release		
Other Chemical	85%	90%
No Release	15%	55%

1/Percentage of full yield obtainable with 2,4,5-T under typical management regime.
2/"Clean log only" refers to more intensive harvest operations that would leave more ground exposed. It may include yarding of unmerchantable material or some other form of slash removal.
3/The use of fire as a substitute may be limited by state and federal smoke management regulations.

Table 4. Management with and without 2,4,5-T in northwestern Oregon

	Stand Age		Revenue or Cost (-) 2/		Volume	
	With 1/	W/O 1/	With	W/O	With	W/O
	yrs.	yrs.	$/acre	$/acre	cunits/acre	
Site Prep	0	0	-60	-45 3/		
Planting Operations	0	0	-130	-130		
Rehabilitation	0	0	-200	-200 3/		
Release	2	2	-30	-28 3/		
Release	4	4	-30	-28 3/		
Precommercial Thin	12	12	-95 4/	-95		
Commercial Thin	30	--	1,144	None	12.3	None
Commercial Thin	35	35	884	1,209	9.5	13.0
Commercial Thin	45	45	1,144	1,311	12.3	14.1
Harvest	65	65	11,668	9,399	94.1	75.8
Slash Disposal	65	65	-110	-110		

1/"With" refers to "with 2,4,5-T," i.e., the typical management practices. "W/O" refers to "without 2,4,5-T," i.e., the alternative management practices.
2/Revenues and costs are for a single rotation, current dollars.
3/Weighted average cost of substitute treatments for 2,4,5-T identified in Table 3; see Appendix B for method.
4/Because of initial stocking levels and anticipated early stand development, precommercial thinning is estimated to be needed on only 25 percent of the land area. This proportional treatment was used in the economic analysis.

The unavailability of 2,4,5-T for forestry uses would require alternative practices for those situations described above. These alternative practices are listed in table 5. The resulting alternative management is contrasted to typical management in table 6.

In southwestern Oregon, a reduction of 31 cubic feet per acre per year (a loss of 23 percent) is expected if 2,4,5-T is not available (table 11).

A more detailed case study for southwestern Oregon is found in Appendix A.

OREGON CASCADES

Typical management in the Oregon Cascades involves the use of 2,4,5-T on 50 percent of the commercial forest land. Fifty percent of the release operations, 30 percent of the rehabilitation projects, and 15 percent of the site preparation activities occurring on forest lands in this area typically use 2,4,5-T.

Alternatives to these silvicultural uses of 2,4,5-T in the Oregon Cascades are listed in table 7. The management resulting from the use of these substitutes is contrasted with typical management in table 8.

If 2,4,5-T is not available for forestry use a loss of 24 cubic feet per acre per year is predicted--a reduction of 16 percent (table 11).

EASTERN OREGON

The use of 2,4,5-T for site preparation and rehabilitation of unproductive forest lands is incidental and is not included in this analysis. Release is the only silvicultural practice significantly dependent on 2,4,5-T. Approximately 19 percent of the forest land base could potentially benefit from a release spray containing

Table 5--Silvicultural substitutes for 2,4,5-T in southwestern Oregon

Silvicultural Substitutes for 2,4,5-T	Percent Replacement for 2,4,5-T	Percent 1/ Yield
Site Preparation		
Clean Log Only 2/	60%	60%
Hand Slash, Other Chem., and Fire 3/	25%	100%
Fire	15%	95%
Rehabilitation		
Hand Slash, Other Chem., and Fire 3/	60%	100%
No Rehabilitation	25%	20%
Other Chemical	15%	85%
Release		
Other Chemical	50%	95%
No Release	35%	60%
Hand Slashing	15%	85%

1/Percentage of full yield obtainable with 2,4,5-T under typical management regime.
2/"Clean log only" refers to more intensive harvest operations that would leave more ground exposed. It may include yarding of unmerchantable material or some other form of slash removal.
3/The use of fire as a substitute may be limited by state and federal smoke management regulations.

Table 6--Management with and without 2,4,5-T in southwestern Oregon

Practice	Stand Age With 1/	Stand Age W/O 1/	Revenue or Cost (-) 2/ With	Revenue or Cost (-) 2/ W/O	Volume With	Volume W/O
	yrs.	yrs.	$/acre	$/acre	cunits/acre	
Site Prep	0	0	- 60	- 78 3/		
Planting Operations	0	0	-130	-130		
Rehabilitation	0	0	-200	-211 3/		
Release	4	4	-30	-150 3/		
Release	6	6	-30	-150 3/		
Release	--	9	--	-376 3/ 4/		
Precommercial Thin	15	15	-95 5/	- 95		
Commercial Thin	40		1,247	none	13.4	none
Commercial Thin	50	45	1,153	1,116	12.4	12.0
Commercial Thin	65	60	1,088	1,163	11.7	12.5
Harvest	85	85	9,511	7,775	76.7	62.7
Slash Disposal	85	85	-110	-110		

1/"With" refers to "with 2,4,5-T," i.e., the typical management practices. "W/O" refers to "without 2,4,5-T," i.e., the alternative management practices.

2/Revenues and costs are for a single rotation, current dollars.

3/Weighted average cost of substitute treatments for 2,4,5-T identified in Table 5; see Appendix C for method.

4/All release operations in this alternative in southwestern Oregon include manual release on 15 percent of the area. Costs are mid-range values from RPAR timber assessments.

5/Because of initial stocking levels and anticipated early stand development, precommercial thinning is estimated to be needed on only 40 percent of the land area. This proportional treatment was used in the economic analysis.

Table 7--Silvicultural substitutes for 2,4,5-T in the Oregon Cascades

Silvicultural Substitutes for 2,4,5-T	Percent Replacement for 2,4,5-T	Percent 1/ Yield
Site Preparation		
Clean Log Only 2/	90%	80%
Other Chemical	10%	100%
Rehabilitation		
Other Chemical	35%	100%
No Rehabilitation	25%	50%
Hand Slash, Other Chem., and Fire	20%	115%
Mechanical	20%	110%
Release		
Other Chemical	50%	100%
No Release	50%	75%

1/Percentage of full yield obtainable with 2,4,5-T under typical management regime.
2/"Clean log only" refers to more intensive harvest operations that would leave more ground exposed. It may include yarding of unmerchantable material or some other form of slash removal.

Table 8--Management with and without 2,4,5-T in the Oregon Cascades

Practice	Stand Age With 1/	Stand Age W/O 1/	Revenue or Cost (-) 2/ With	Revenue or Cost (-) 2/ W/O	Volume With	Volume W/O
	yrs.	yrs.	$/acre	$/acre	cunits/acre	
Site Prep	0	0	-60	-9 3/		
Planting Operations	0	0	-130	-130		
Rehabilitation	0	0	-200	-180 3/		
Release	5	5	-30	-45 3/		
Precommercial Thin	13	13	-95 4/	-95		
Commercial Thin	35	--	1,125	none	12.1	none
Commercial Thin	45	40	1,200	1,200	12.9	12.9
Commercial Thin	60	50	1,247	1,088	13.4	11.7
Harvest	75	75	9,412	8,940	75.9	72.1
Slash Disposal	75	75	-110	-110		

1/"With" refers to "with 2,4,5-T," i.e., the typical management practices. "W/O" refers to "without 2,4,5-T," i.e., the alternative management practices.

2/Revenues and costs are for a single rotation, current dollars.

3/Weighted average cost of substitute treatments for 2,4,5-T identified in Table 7; see Appendix B for method.

4/Because of initial stocking levels and anticipated early stand development, precommercial thinning is estimated to be needed on only 90 percent of the land area. This proportional treatment was used in the economic analysis.

2,4,5-T. The alternatives to using 2,4,5-T for release are listed in table 9. Management resulting from the use of substitutes is contrasted with typical management in table 10.

If 2,4,5-T is not available for use in eastern Oregon, a reduction of 12 cubic feet per acre per year (a loss of 23 percent) is expected on areas needing 2,4,5-T for release. This represents a large proportionate impact on yield, but because of the lower productivity of typical eastern Oregon sites and the comparatively small area which would use 2,4,5-T, the total yield reduction is less than in other areas.

ECONOMIC EFFICIENCY

In all areas of the State where 2,4,5-T is part of the preferred treatment, management with 2,4,5-T is economically more efficient than management without 2,4,5-T (tables 12 and 13). The greatest difference in management efficiency is found in southwestern Oregon. Here management with 2,4,5-T results in a return of $3.80 per acre for every dollar invested, compared with a return of $1.68 without 2,4,5-T (table 12, WRC rates).

On a Statewide basis, management with 2,4,5-T results in $288 per acre greater present net worth than management without 2,4,5-T. Since 2,4,5-T has the potential for use on 11 million acres (table 1), or 253,000 acres annually, management with 2,4,5-T could provide as much as $1.1 billion greater present net worth from these lands than management without 2,4,5-T. In other terms, the benefit-cost ratio with 2,4,5-T indicates a return of $4.13 for every dollar invested in management, dropping to $2.43 in the absence of 2,4,5-T.

In eastern Oregon, lower timber production makes management less profitable than in other areas. The analysis shows that management with 2,4,5-T is efficient at approximately the 6 percent discount

level or less. It must be understood, however, that only timber values are included in this assessment. Inclusion of other commodities could result in substantial changes.

SILVICULTURE COSTS

Proportional changes in silvicultural costs and yields with and without 2,4,5-T are shown in Figure 3. These values compare the average undiscounted management costs of alternatives on potential use areas. They could be viewed as likely changes in silvicultural budgets if 2,4,5-T is not available.

If 2,4,5-T becomes unavailable, costs are expected to decrease slightly in northwestern Oregon, but yields will also be reduced. Anticipated budget costs of alternatives increase in all other areas, reaching a maximum in southwestern Oregon. The likely management alternatives in this area would require a 67 percent increase in silviculture budgets, but even with these added expenditures, yields would be reduced by 23 percent. Similar comparisons can be made for each geographic area.

STATE IMPACTS

TIMBER SUPPLY IMPACTS

Reductions in timber yield without 2,4,5-T have been expressed only in terms of loss on areas that would potentially use 2,4,5-T for one or more silvicultural operations. However, these areas represent only a portion of the total commercial forest land area (table 1). To assess the net change in wood volume production with and without 2,4,5-T, the entire commercial forest land area must be evaluated. To simplify this analysis, changes in wood production on areas using 2,4,5-T are expressed as a proportion of change in production on all commercial forest lands in each region (table 14).[1/] This analysis assumes

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1/Procedural details are shown in Appendix B.

Table 9--Silvicultural substitutes for 2,4,5-T in eastern Oregon

Silvicultural Substitutes for 2,4,5-T	Percent Replacement for 2,4,5-T	Percent 1/ Yield
Release		
No Release	39%	66%
Mechanical	33%	80%
Other Chemical	28%	90%

1/Percentage of full yield obtainable with 2,4,5-T under typical management regime.

Table 10--Management with and without 2,4,5-T in eastern Oregon

Practice	Stand Age With 1/	Stand Age W/O 1/	Revenue or Cost (-) 2/ With	Revenue or Cost (-) 2/ W/O	Volume With	Volume W/O
	yrs.	yrs.	$/acre	$/acre	cunits/acre	
Planting Operations	0	0	-130	-130		
Release	6	6	-60	-144 3/		
Precommercial Thin	13	20	-85 4/	-85		
Commercial Thin	40	--	249	none	4.0	none
Commercial Thin	60	60	461	548	7.4	8.8
Commercial Thin	80	80	498	386	8.0	6.2
Harvest	120	120	3,340	2,575	40.2	31.0
Slash Disposal	120	120	-110	-110		

1/"With" refers to "with 2,4,5-T," i.e., the typical management practices. "W/O" refers to "without 2,4,5-T," i.e., the alternative management practices.
2/Revenues and costs are for a single rotation, current dollars.
3/Weighted average cost of substitute treatments for 2,4,5-T identified in Table 9; see Appendix B for method.
4/Because of initial stocking levels and anticipated early stand development, precommercial thinning is estimated to be needed on only 35 percent of the land area. This proportional treatment was used in the economic analysis.

Table 11--Potential productivity with and without 2,4,5-T for areas which would use 2,4,5-T for vegetation management

Geographic Area	Potential Productivity Mean Annual Increment with 2,4,5-T cu. ft./ acre/year)	Potential Productivity Mean Annual Increment without 2,4,5-T cu. ft./ acre/year)	Difference 1/ cu.ft./ acre/year	Difference 1/ percent
Northwestern	197	158	-39	-19%
Southwestern	134	103	-31	-23%
Cascade Range	152	128	-24	-16%
Eastern	50	38	-12	-23%

1/ Compared with potential productivity with 2,4,5-T. Percentages are adjusted to compensate for rounding differences in DFIT simulations.

Table 12--Benefit-cost ratios for management with and without 2,4,5-T in Oregon

Geographic Area	Management Alternative	Benefit-cost Ratio at Discount Rate of:			
		4%	6-5/8%	8%	10%
Northwestern	With 2,4,5-T	24.98	6.73	3.58	1.54
	Without 2,4,5-T	20.37	5.21	2.66	1.06
Southwestern	With 2,4,5-T	19.27	3.80	1.79	.67
	Without 2,4,5-T	9.12	1.68	.76	.26
Cascades	With 2,4,5-T	19.32	4.55	2.29	.92
	Without 2,4,5-T	16.82	3.74	1.81	.68
Eastern	With 2,4,5-T	5.24	.74	.33	.13
	Without 2,4,5-T	2.98	.36	.14	.04
State	With 2,4,5-T		4.13		
	Without 2,4,5-T		2.43		

TABLE 13--Present net worth per acre for management with and without 2,4,5-T in Oregon

Geographic Area	Management Alternative	Present Net Worth at Discount Rate of: 4%	6-5/8%	8%	10%
Northwestern	With 2,4,5-T	6,413	1,349	591	121
	Without 2,4,5-T	5,023	962	368	13
	Difference	1,390	387	223	108
Southwestern	With 2,4,5-T	4,201	578	158	-65
	Without 2,4,5-T	2,955	218	-74	-212
	Difference	1,246	360	232	147
Cascades	With 2,4,5-T	4,801	805	280	-16
	Without 2,4,5-T	4,014	598	168	-64
	Difference	787	207	112	48
Eastern	With 2,4,5-T	841	-48	-119	-151
	Without 2,4,5-T	515	-152	-195	-207
	Difference	326	104	76	56
State	With 2,4,5-T		666		
	Without 2,4,5-T		378		
	Difference		288		
State (Total)[1/]	Potential Level (253,000 acres treated annually)		$1.10 billion		
	Current Level (88,000 acres treated annually)		$383 million		

[1/] The equation for a perpetual series of annual payments was used to estimate present net worth loss without 2,4,5-T.

$$V_o = \frac{a}{i}$$ Where V_o = present net worth;
a = periodic payment (i.e. net revenue or cost; or difference in per acre value); and
i = annual interest rate (i.e. 6 5/8 percent).

$$\text{e.g. } V_o = \frac{(\$288/\text{acre})(253{,}000 \text{ acres})}{0.06625}$$

that the 2,4,5-T acres are of average productivity. In fact, 2,4,5-T acres tend to be more productive, thereby supporting more competing vegetation that must be controlled. Thus, the weighted average yield impact in each region tends to be a conservative estimate.

These yield impacts were applied to long-term projections of timber supply in order to estimate total volume reduction within each region.[1/] This expansion of results is based on the assumption that per-acre changes in productivity from this 2,4,5-T assessment are directly proportional to changes in productivity for the area as a whole. The results are shown in figures 4-8. The intensity of management now being practiced in Oregon is approximated by the "A-1" level (Beuter et al. 1976). Management at this level would result in a timber supply decline in western Oregon by the year 2000. The curves reflecting a higher level of management, labeled "FPFO", are based on maintaining future harvest levels at or above the current harvest levels (OSDF 1977). [2/]

1/The general form of the projection is given by the equation:

$$\text{supply at year n without 2,4,5-T} = (1-a) + ay \quad S_n$$

Where: a = proportion of area using 2,4,5-T
y = proportion of full yield attainable without 2,4,5-T
S_n = projected supply at year n

2/Both projection studies cited used linear programing techniques which may give substantially different results from per-acre projections. However, in a comparison of both techniques on the Siskiyou National Forest in southwestern Oregon, the per-acre projection method gave approximately the same result as linear programing using Timber-RAM (Navon 1971). These results are on file with USDA Forest Service, Pacific Northwest Region, Portland, Oregon.

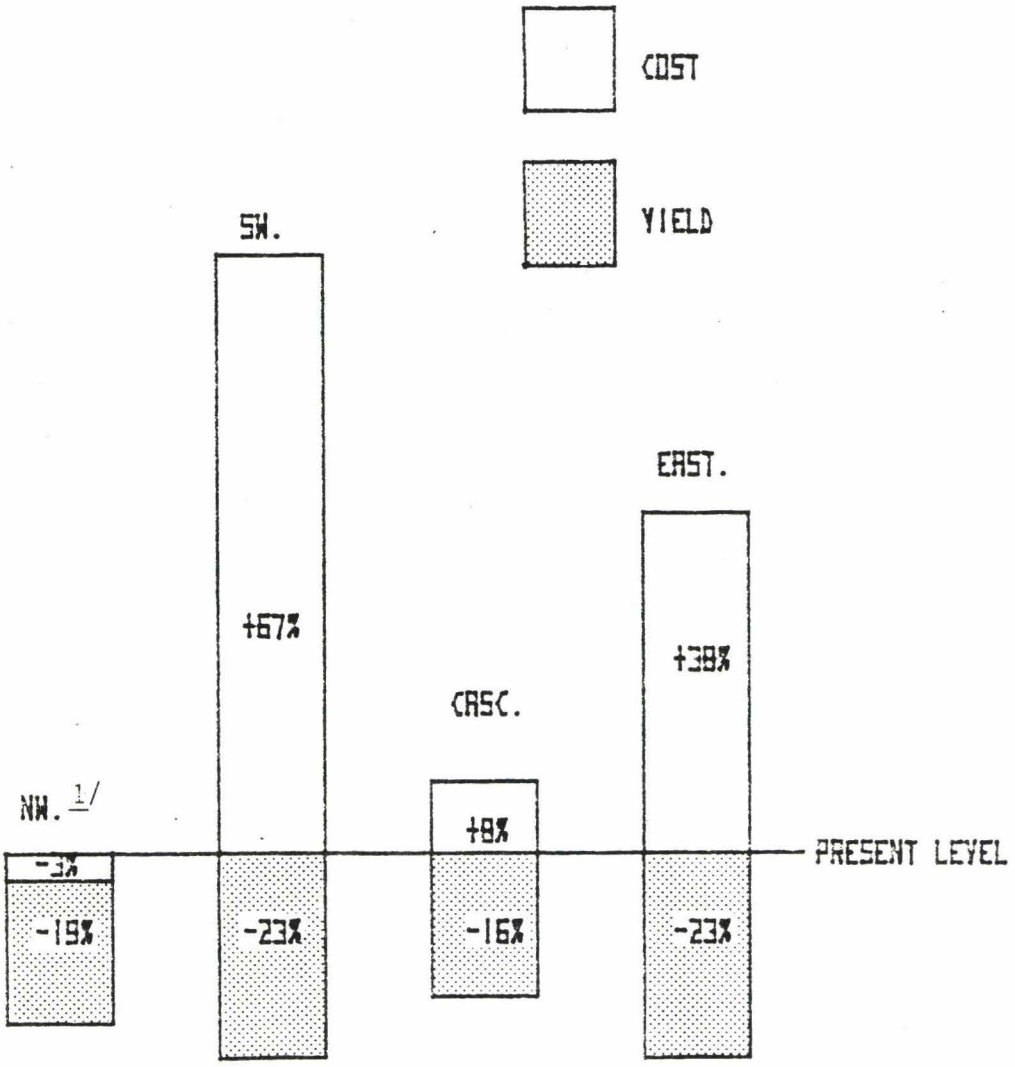

FIGURE 3. CHANGES IN SILVICULTURE COSTS AND TIMBER YIELDS ON POTENTIAL USE AREAS IF 2,4,5-T IS UNAVAILABLE.

1/This decrease in silvicultural costs in northwestern Oregon occurs because alternatives to 2,4,5-T, though less effective, are only slightly more expensive in this region, and 15 percent of the time no release is done (and no expense incurred). The combined impact is a slight reduction in silvicultural cost.

Table 14--Summary of yield effects for management without 2,4,5-T

Region	Yield on 2,4,5-T Areas	Overall Yield 1/
Northwestern	81%	86%
Southwestern	77%	83%
Cascades	84%	93%
Eastern	77%	96%
State	--	89%

1/Percentage of full yield obtainable with 2,4,5-T. Includes the yield from 2,4,5-T areas plus the areas not requiring 2,4,5-T. See equation, footnote 2, p. 30.

In northwestern Oregon, for example, yield without 2,4,5-T is 86 percent of the potential yield with 2,4,5-T. Total harvest would decline about 14 percent from the projected 300 million cubic feet per year[1/] through the year 2000--a loss of 42 million cubic feet (206 million board feet) annually. Thereafter, as the full yield potential with 2,4,5-T rose, potential impacts would increase, culminating in losses of over 45 million cubic feet (220 million board feet) per year by the year 2070 if 2,4,5-T were unavailable and no new substitutes were introduced.

EMPLOYMENT IMPACTS

One of the most critical social and economic changes resulting from a reduction of timber supplies is loss of employment. About 20,000 jobs will potentially by lost if 2,4,5-T is unavailable (table 15, figure 9), based on timber supply projections for the first three decades. The economic impact of this job loss is additional to the loss of stumpage revenue.

SUMMARY

If 2,4,5-T is unavailable for forestry use in Oregon, a range of substitute practices would be used in the four major areas of the State. In some situations, no suitable substitutes are available. These practices generally result in increased silvicultural costs ranging from -3 percent to +67 percent of present levels. They are less efficient economically than the use of 2,4,5-T on potential use areas. Furthermore, use of these alternatives could potentially result in a loss of more than $1.1 billion in present net worth and an 11 percent reduction in timber yield--a current annual loss of 936 million board feet. The employment impacts of this reduction are estimated to be about 20,000 jobs, including both primary and secondary employment.

[1/] Beuter et al. 1976, A-1 level.

These impacts would be most heavily felt in western Oregon. In this area, not only are vegetative types more dependent upon the use of herbicides, but timber supplies are also critically short (Beuter et al. 1976). If 2,4,5-T is not available, projections in this study indicate that current harvest levels in this area and the State as a whole cannot be maintained.

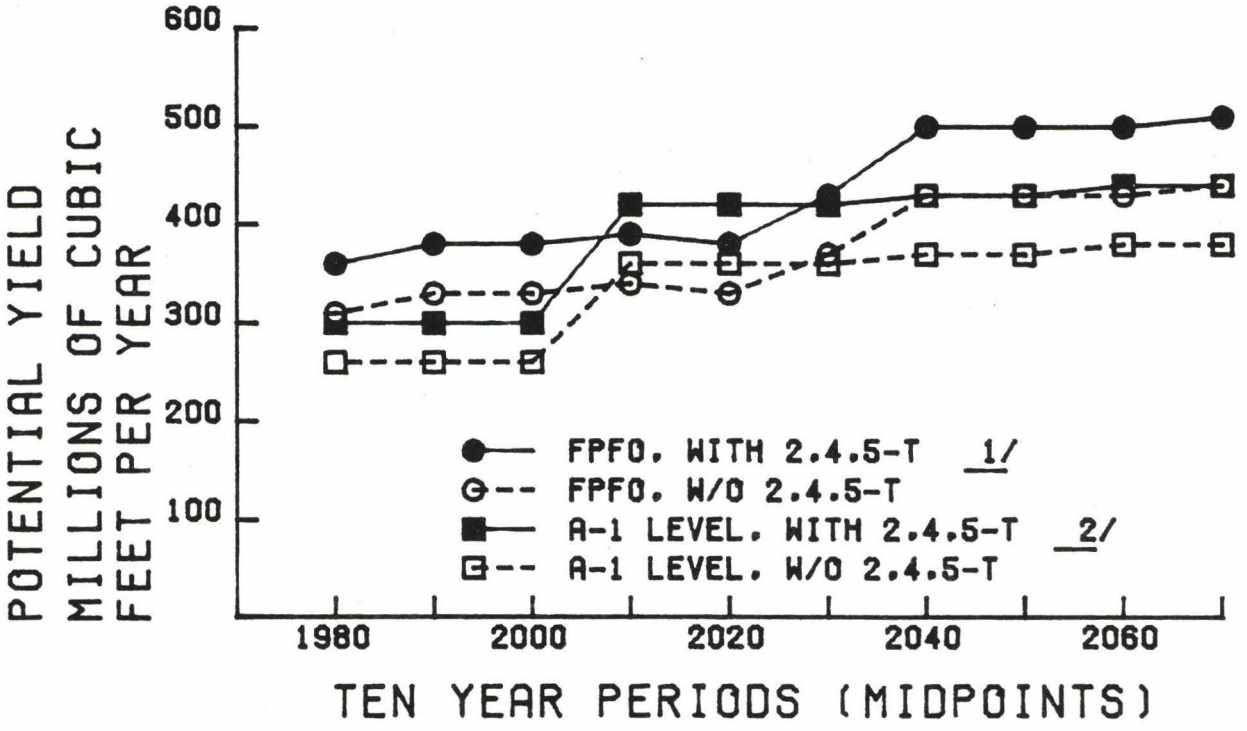

FIGURE 4. HARVEST PROJECTIONS FOR TWO MANAGEMENT INTENSITIES IN NORTHWEST OREGON, SHOWING ANTICIPATED LEVELS WITH AND WITHOUT 2,4,5-T.

1/ FPFO: Forestry Program for Oregon (OSDF 1977). The anticipated level of management needed to maintain future harvest levels at or above current levels. Projected yield without 2,4,5-T would fall 14 percent short of FPFO potential.

2/ A-1 level (Beuter et al. 1976). The harvest levels anticipated if current policies and resultant management intensities are projected into the future. Projected yield without 2,4,5-T would fall 14 percent short of A-1 level.

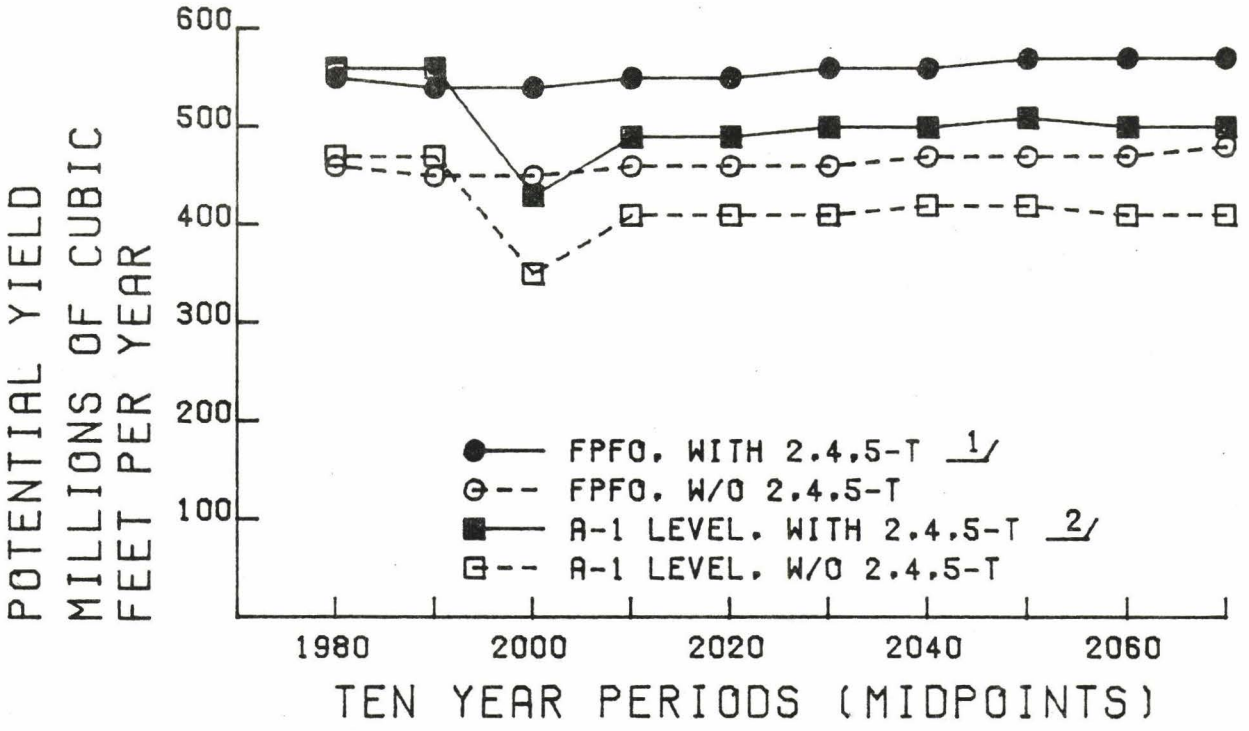

FIGURE 5. HARVEST PROJECTIONS FOR TWO MANAGEMENT INTENSITIES IN SOUTHWEST OREGON, SHOWING ANTICIPATED LEVELS WITH AND WITHOUT 2,4,5-T

1/FPFO: Forestry Program for Oregon (OSDF 1977). The anticipated level of management needed to maintain future harvest levels at or above current levels. Projected yield without 2,4,5-T would fall 17 percent short of FPFO potential.

2/A-1 level (Beuter et al. 1976). The harvest levels anticipated if current policies and resultant management intensities are projected into the future. Projected yield without 2,4,5-T would fall 17 percent short of A-1 level.

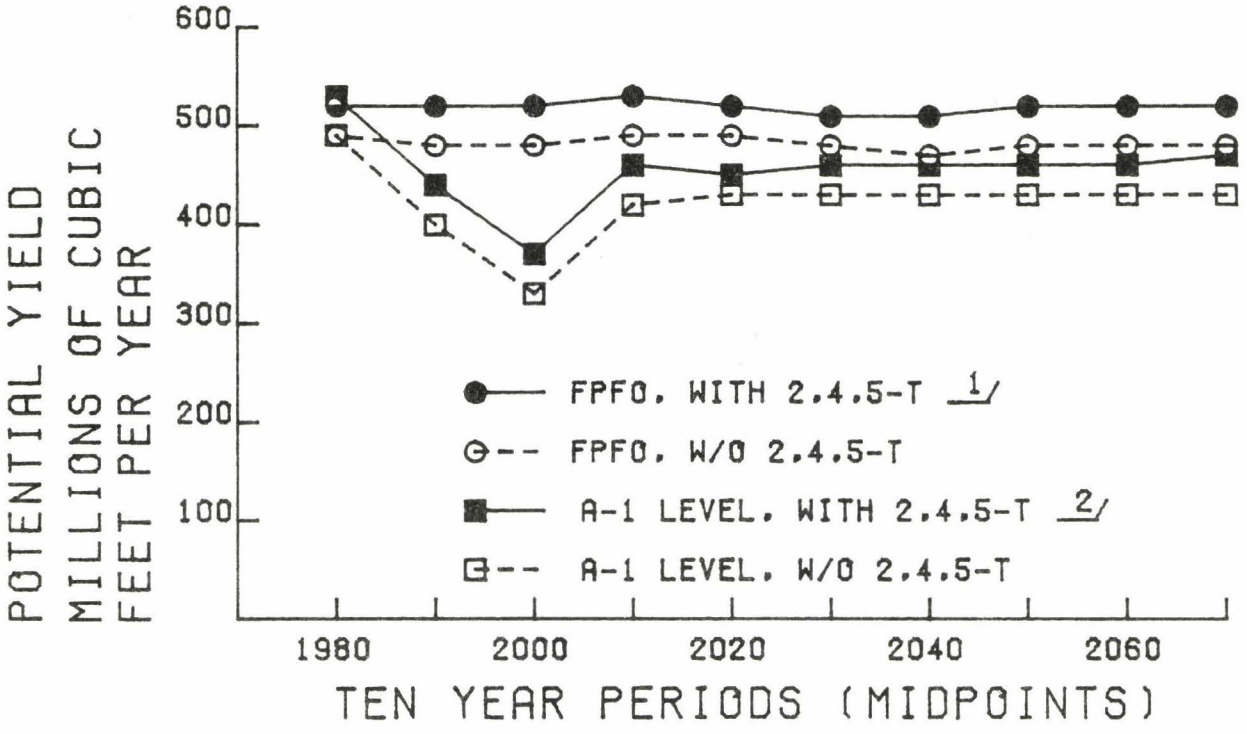

FIGURE 6. HARVEST PROJECTIONS FOR TWO MANAGEMENT INTENSITIES IN CASCADES OF OREGON, SHOWING ANTICIPATED LEVELS WITH AND WITHOUT 2,4,5-T

1/ FPFO: Forestry Program for Oregon (OSDF 1977). The anticipated level of management needed to maintain future harvest levels at or above current levels. Projected yield without 2,4,5-T would fall 7 percent short of FPFO potential.

2/ A-1 level (Beuter et al. 1976). The harvest levels anticipated if current policies and resultant management intensities are projected into the future. Projected yield without 2,4,5-T would fall 7 percent short of A-1 level.

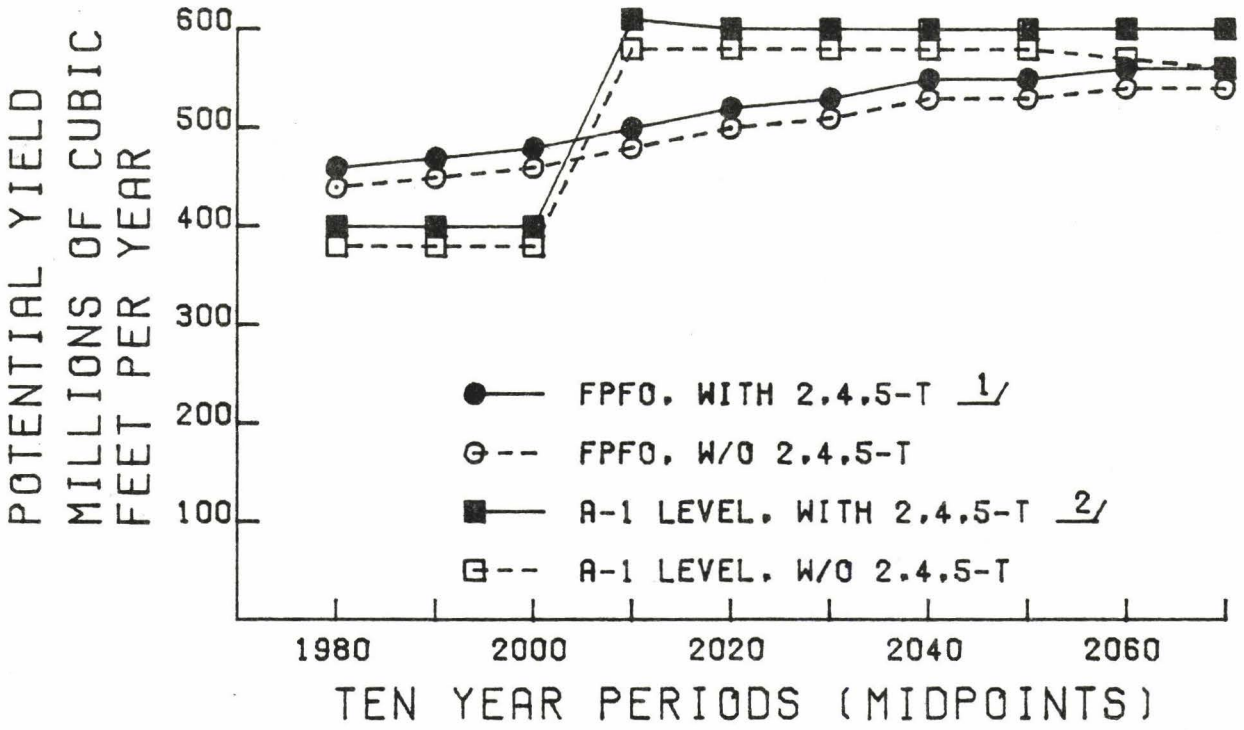

FIGURE 7 . HARVEST PROJECTIONS FOR TWO MANAGEMENT INTENSITIES IN EASTERN OREGON, SHOWING ANTICIPATED LEVELS WITH AND WITHOUT 2,4,5-T

1/ FPFO: Forestry Program for Oregon (OSDF 1977). The anticipated level of management needed to maintain future harvest levels at or above current levels. Projected yield without 2,4,5-T would fall 4 percent short of FPFO potential.

2/ A-1 level (Beuter et al. 1976). The harvest levels anticipated if current policies and resultant management intensities are projected into the future. Projected yield without 2,4,5-T would fall 4 percent short of A-1 level.

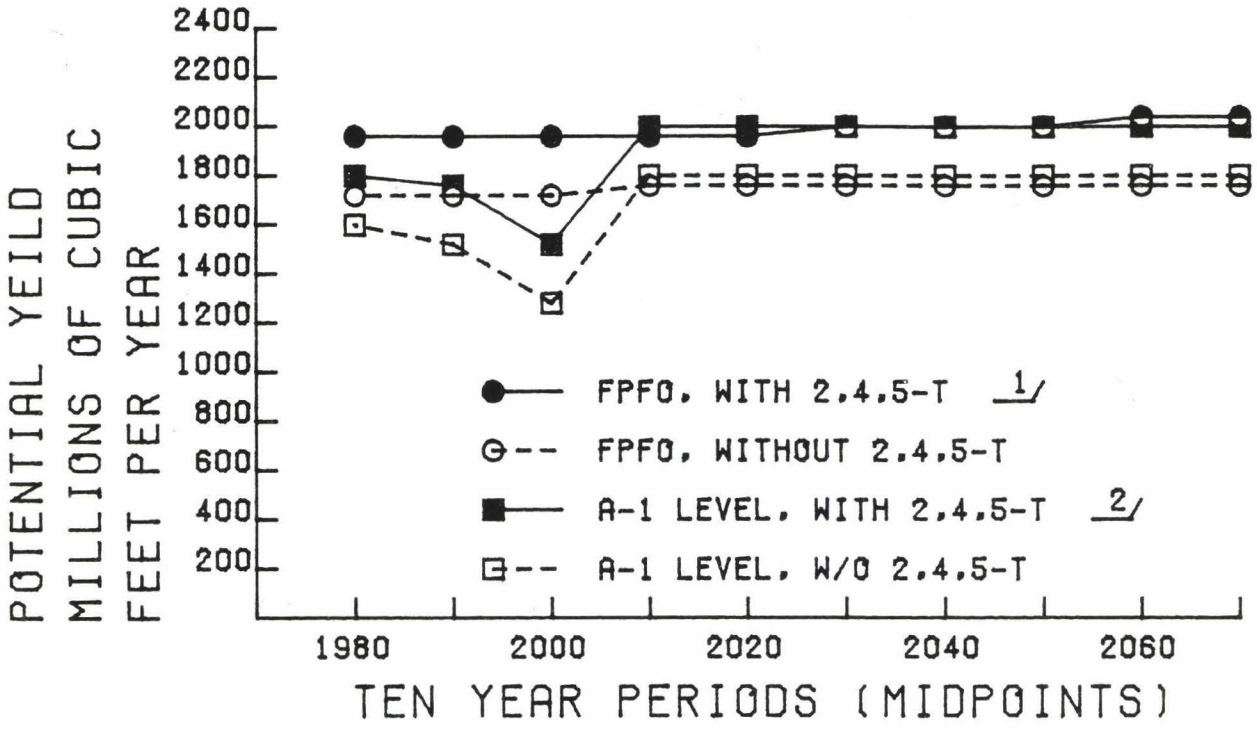

FIGURE 8. HARVEST PROJECTIONS FOR TWO MANAGEMENT INTENSITIES IN STATE OF OREGON, SHOWING ANTICIPATED LEVELS WITH AND WITHOUT 2,4,5-T

1/ FPFO: Forest Program for Oregon (OSDF 1977). The anticipated level of management needed to maintain future harvest levels at or above current levels. Projected yield without 2,4,5-T would fall 11 percent short of FPFO potential.

2/ A-1 level (Beuter et al. 1976). The harvest levels anticipated if current policies and resultant management intensities are projected into the future. Projected yield without 2,4,5-T would fall 11 percent short of A-1 level.

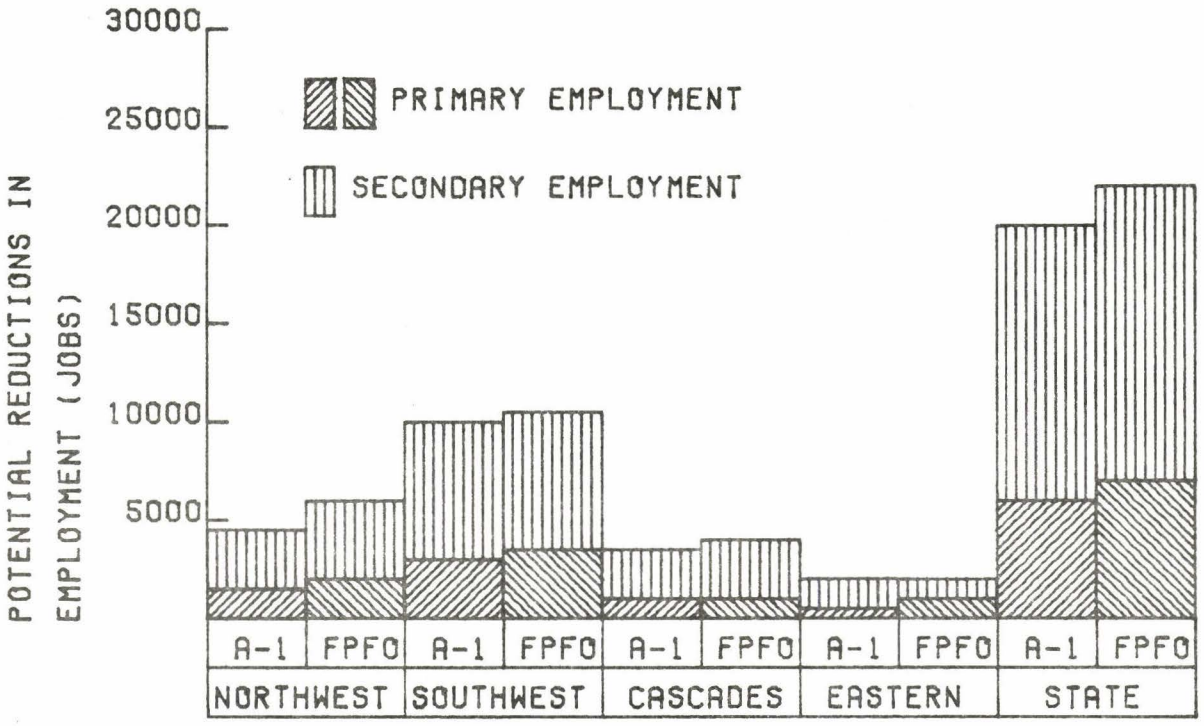

FIGURE 9. POTENTIAL REDUCTIONS IN TIMBER-RELATED EMPLOYMENT, 1980-2000, FROM LOSS OF 2,4,5-T

Table 15--Potential losses in yield and employment if 2,4,5-T is unavailable in Oregon 1/

	Geographic Area				
	Northwestern	Southwestern	Cascades	Eastern	State Total
	---Yield impacts, MMCF (percent)---				
Current Annual Yield	300	563	530	400	1,793
Reduction Without 2,4,5-T	-42(-14%)	-96(-17%)	-37(-7%)	-16(-4%)	-191(-11%)
Yield Without 2,4,5-T, MMCF	258	467	493	384	1,602
	---Yield impacts, MMBF---				
Current Annual Yield	1,470	2,759	2,597	1,960	8,786
Reduction Without 2,4,5-T	-206	-470	-181	-78	-936
Yield Without 2,4,5-T	1,264	2,289	2,416	1,882	7,850
	---Employment impacts, average job loss 1980-2000---				
Direct Employment Loss	1,546	3,235	1,145	589	6,515
Indirect Employment Loss	3,091	6,469	2,289	1,178	13,027
Total Employment Loss	4,637	9,704	3,434	1,767	19,542

1/Based on A-1 levels, representing current intensity of management. FPFO levels are approximately 13 percent greater.

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APPENDIX A
SOUTHWESTERN OREGON CASE ANALYSIS

In southwestern Oregon substitute vegetation management practices could be used on part of the commercial forest if 2,4,5-T were unavailable. These substitutes were discussed and analyzed within the body of the report using a composite approach (e.g., see tables 5 and 6).

The following discussion goes still further. It independently examines the effects of each of the major substitute methods by displaying likely yields and economic efficiencies. In essence, the discussion presents an expanded case analysis for a major timber producing area within Oregon.

RELEASE

The total area which would use 2,4,5-T was described in table 1. In southwestern Oregon, 58 percent of the commercial forest land would use 2,4,5-T just for release. Site preparation on these areas would result from logging and slash disposal from the previous rotation. Thus, the early stand development costs prior to release are the same for 2,4,5-T and its alternatives. It is only at the time of release treatment that differences between alternatives become apparent. From this point on, the cost and yield differences from the use of 2,4,5-T or its substitutes can be evaluated.

These effects are displayed in table A-1. It should be noted that if 2,4,5-T is unavailable, the next most efficient method may not be an alternative on a particular site. For example, although other chemical substitutes are economically more efficient than hand slashing or no release treatment, these chemicals will not effectively control many of the vegetative types in southwestern Oregon. This is why other chemical substitutes would be selected only about half the time (table 5).

Table A-1--The expected efficiency of alternative release methods on areas which would potentially use 2,4,5-T in southwestern Oregon [1/]

Release Method	Percent Use 2/	Percent Timber Yield	Economic Efficiency 3/ Present Net Worth	Diff. From 2,4,5-T 4/	Benefit-Cost Ratio
2,4,5-T	--	100%	$612	--	4.23
Other Chemical	50%	95%	$518	-$94	3.51
No Release	35%	60%	$196	-$416	2.34
Hand Slashing	15%	85%	-$273	-$885	.70

1/Assumes site preparation was accomplished from logging and slash disposal in the previous rotation.
2/Percent of time the method would be used if 2,4,5-T were unavailable. From survey of silviculturists.
3/At Water Resources Council rate, 6-5/8 percent discount.
4/The expected difference in present net worth of the substitute method is used to replace 2,4,5-T.

Table A-2--The expected efficiency of alternative methods of vegetation control in southwestern Oregon 1/

Table A-2--The expected efficiency of alternative methods for site preparation, rehabilitation, and release in southwestern Oregon[1/]

Method of Site Preparation	Method of Release: 2,4,5-T Yield % [2/]	2,4,5-T PNW $	2,4,5-T B/C	Other Chemical Yield %	Other Chemical PNW $	Other Chemical B/C	None Yield %	None PNW $	None B/C	Hand Slash Yield %	Hand Slash PNW $	Hand Slash B/C
2,4,5-T	100%	$534	3.14									
Clean Logging				54%	$114	1.59	33%	$10	1.07	52%	-$624	.31
Hand Slash-Other Chemical-Fire				90%	$130	1.26	55%	-$145	.68			
Fire				86%	$442	3.30	52%	$137	1.94			
Method of Rehabilitation												
2,4,5-T	100%	$364	2.01									
Other Chemical				76%	$81	1.18	47%	-$150	.62			
No Rehabilitation							11%	-$80	.45			
Hand Slash-Other Chemical-Fire				90%	$130	1.26	55%	-$145	.68	86%	-$564	.53

[1/] Does not include areas which would use 2,4,5-T only for release.

[2/] Yield is in comparison with use of 2,4,5-T.
PNW = Present Net Worth
B/C = Benefit-Cost Ratio

OTHER TREATMENTS

The herbicide 2,4,5-T is used for rehabilitation and release on 2 percent and for site preparation and release on 15 percent of the commercial forest land in southwestern Oregon. The most likely management substitutes for 2,4,5-T for site preparation, rehabilitation, and release combinations are shown in table A-2. These substitutes are contrasted with management with 2,4,5-T to show yield effects and economic efficiencies as in the previous case where release alone was examined. The analysis isolates the specific management practices rather than building a composite analysis such as that used in the main report.

APPENDIX B

SAMPLE DERIVATION OF YIELD IMPACTS

The following calculations show how the impact of cancelling forestry uses of 2,4,5-T was calculated for each silvicultural operation and how the weighted average impact for each region was derived. The Northwest Coast Range is used as an example.

STEP 1.

Selection of alternatives to 2,4,5-T. Based on the survey, the following alternative management practices were identified by one or more silviculturists for each operation. Those with an asterisk were, by consensus, the most prevalent. The proportion of use within the region for the most prevalent alternatives as derived from the survey is shown in the right-hand column. "Chemical" refers to the use of alternative chemicals that are currently registered for use.

Site Preparation Alternatives	Proportion of Use
*Chemical	0.15
*Fire	0.30
*Chemical and Fire	0.35
*No Management (clean log only)	0.20
Mechanical	--
Hand	--

Rehabilitation Alternatives	Proportion of Use
*Chemical	0.35
*Slash, Chemical, and Fire	0.50
*No Management	0.15
Chemical and Fire	--
Mechanical	--

Release Alternatives	Proportion of Use
*Chemical	0.85
*No Management	0.15
Hand	--

STEP 2.

Calculation of weighted average yield impact by silvicultural operation. Survey respondents estimated the yield impact (i.e., difference in yield attributable to using an alternative practice instead of a practice including 2,4,5-T). The average response of each alternative is shown below. The weighted average impact for each silvicultural operation overall was derived by multiplying the proportion of use by the yield impact for each alternative and summing the products.

Site Preparation

Alternative	Average Estimated Yield Impact*	Proportion of Use	Product (Yield x Use)
Fire	0.90	0.30	0.27
Chemical	1.00	0.15	0.15
Chemical and Fire	1.00	0.35	0.35
No Management (clean log)	0.70	0.20	0.14
Weighted Average			0.91

Rehabilitation

Alternative	Average Estimated Yield Impact*	Proportion of Use	Product (Yield x Use)
Chemical	0.85	0.35	0.30
Slash, Chemical, and Fire	1.00	0.50	0.50
No Management	0.10	0.15	0.015
Weighted Average			0.81

Release

Alternative	Average Estimated Yield Impact*	Proportion of Use	Product (Yield x Use)
Chemical	0.90	0.85	0.77
No Management	0.55	0.15	0.08
Weighted Average			0.85

*Estimated yield impacts are expressed as a proportion of yield obtainable with 2,4,5-T.

STEP 3.

Calculation of yield impact by not using 2,4,5-T in each region. A weighted average yield impact in each region was derived by multiplying the proportion of each silvicultural operation by its corresponding yield impact and adding the products. Survey results indicated that the number of acres needing 2,4,5-T for release equalled the total acres using 2,4,5-T for one or more silvicultural operations. It is assumed that 2,4,5-T is used for release on all the 2,4,5-T acres. In addition, it is also used for site preparation and rehabilitation on a portion of these areas. Thus, three combinations of silvicultural operations with 2,4,5-T had to be proportioned to derive a weighted yield impact; namely, site preparation and release, rehabilitation and release, and release alone. The example below shows how the operations were proportioned and the weighted average yield impact calculated.

	(Thousands of Acres)
a. Commercial forest land in N.W. Oregon[1/]	2,871.40
b. Total use of 2,4,5-T in region = 75 percent of a.[2/]	2,153.55
c. Total acres of rehabilitation[3/]	510.77
d. Rehabilitation with 2,4,5-T = 50 percent of c.[2/]	255.39
e. Remaining acres needing 2,4,5-T = 2,153.55 - 255.39 =	1,898.16
f. Site preparation with 2,4,5-T = 30 percent of e.[2/]	569.45
g. Release only with 2,4,5-T is e. - f. =	1,328.71

[1/] Data from Pacific Northwest Forest and Range Experiment Station.

[2/] Consensus estimate from survey.

[3/] Data from adding "nonstocked regeneration" and "conversion" acres from beginning inventory in Beuter et al., 1976.

Summary of Proportions of 2,4,5-T Operations in northwest Oregon

Operations	Thousands of Acres	Percent
Rehabilitation and Release	255.39	12
Site Preparation and Release	569.45	26
Release Only	1,328.71	62
TOTAL	2,153.55	100

h. Weighted yield impacts using proportions and yield impacts by operation (from Step 2):

	Yield Effects		Prop. of Area		Product
Rehabilitation and Release	0.81 x 0.85	x	0.12	=	0.08
Site Preparation and Release	0.91 x 0.85	x	0.26	=	0.20
Release Only	0.85	x	0.62	=	0.53
Weighted Average =					0.81

Thus, without 2,4,5-T there is a projected 19 percent growth or yield reduction in the northwest Oregon region compared to similar management intensity using 2,4,5-T on total 2,4,5-T acres.

To find the overall yield impact on all commercial forest land in the region, those acres not needing 2,4,5-T for any silvicultural operation must be taken into account:

Acres using 2,4,5-T	0.75 x 0.81 (from Step h.)	= 0.61
Acres not using 2,4,5-T	0.25 x 1.00 (full yield)	= 0.25
Weighted average overall yield impact		= 0.86

APPENDIX C

AMOUNT OF 2,4,5-T USED IN SILVICULTURAL OPERATIONS

CURRENT USE OF 2,4,5-T

The 1976-1977 use of 2,4,5-T for forestry operations in Oregon was determined by surveying commercial and private aerial applicators. 1/ Nineteen companies located in the Pacific Northwest were contacted. Of these, six companies had applied 2,4,5-T in Oregon for forestry purposes in either 1976 or 1977. State and federal land management agencies and most major private owners contracted with one or more of these six applicators to spray 2,4,5-T on their forest lands. These companies sprayed about 81,000 acres in calendar year 1976 and 95,000 acres in calendar year 1977, an average of 88,000 acres per year. Based on current trends, use appears to be increasing in Oregon.

Applicators and agency representatives estimated that figures supplied by these respondents accounted for over 85 percent of the aerial applications for forestry in Oregon during those years. A 100 percent survey was beyond the scope and limitations of this study. Details of the survey are on file.

CURRENT VERSUS POTENTIAL USE

Oregon has about 24 million acres of commercial forest land. Less than half of that acreage, about 11 million acres, has the type of ground cover that might require the application of 2,4,5-T to control undesirable plant species during commercial forest management. Silvicultural operations that require 2,4,5-T occur only during the early ages of a new stand of trees (i.e., 0 to 10 years); older stands in the state do not require the use of 2,4,5-T for effective forest management. Generally, 2,4,5-T is applied from one to three times on

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1/Over 98 percent of all 2,4,5-T for forestry in Oregon was applied aerially as estimated by the survey of silviculturists.

applicable acres during each rotation. Thus, only a small portion of the 11 million acres that might require 2,4,5-T would need treatment in any given year, as depicted in figure C-1, because the large majority of the forest would be older and established.

If all commercial forest lands in Oregon were managed at the intensity assumed in this report, an average of about 253,000 acres per year would require treatment with 2,4,5-T. This is the highest annual application rate which could be expected in the future. Not every commercial forest acre is presently managed this intensively, so the application rate in Oregon averages 88,000 acres per year.

For a variety of reasons that encompass landowner objectives as well as economic, political, and social constraints, the reasonable potential use level in Oregon is not likely to reach the maximum potential use. For example, some of the current constraints include the following:

* Small nonindustrial private lands generally are not managed as intensively as forest lands in other ownerships (because of other management objectives or constraints) and therefore use less 2,4,5-T than the assumed management at the potential level.

* Bureau of Land Management policy precludes the use of 2,4,5-T on forest lands in Oregon.

* National Forest lands include a large area of old growth timber that will not require 2,4,5-T until it is harvested and regenerated.

* Temporary management constraints have been imposed on the aerial application of 2,4,5-T on all forest lands through the Oregon

Forest Practices Act. These restrictions include a 200-foot buffer strip on each side of specified streams and roads and a 500-foot buffer around residences. 1/

This residence buffer has been extended to 1 mile on National Forest lands. Other restrictions have occurred, such as the 1977 court injunction against use of 2,4,5-T on the Siuslaw National Forest. This ban was extended to all National Forest lands in Washington and Oregon, but was lifted following completion of a revised environmental statement.

* Current management intensity for some owners and areas of the State is less than the maximum potential level of management. This is attributable to many reasons, including lack of awareness or knowledge, cash-flow problems, tax disincentives, owner objectives, funding constraints, environmental, political, or legal pressures from interest groups, and slow conversion from old growth to regulated forests.

1/The Oregon State Department of Forestry, in a recent unpublished study on its lands, estimated that 4 percent of the acreage in spray units could not be treated by aerial application of herbicides when buffer strips around streams were one swath width (50-75 feet); with 200-foot wide buffer strips, 18 percent of the acreage is left untreated.

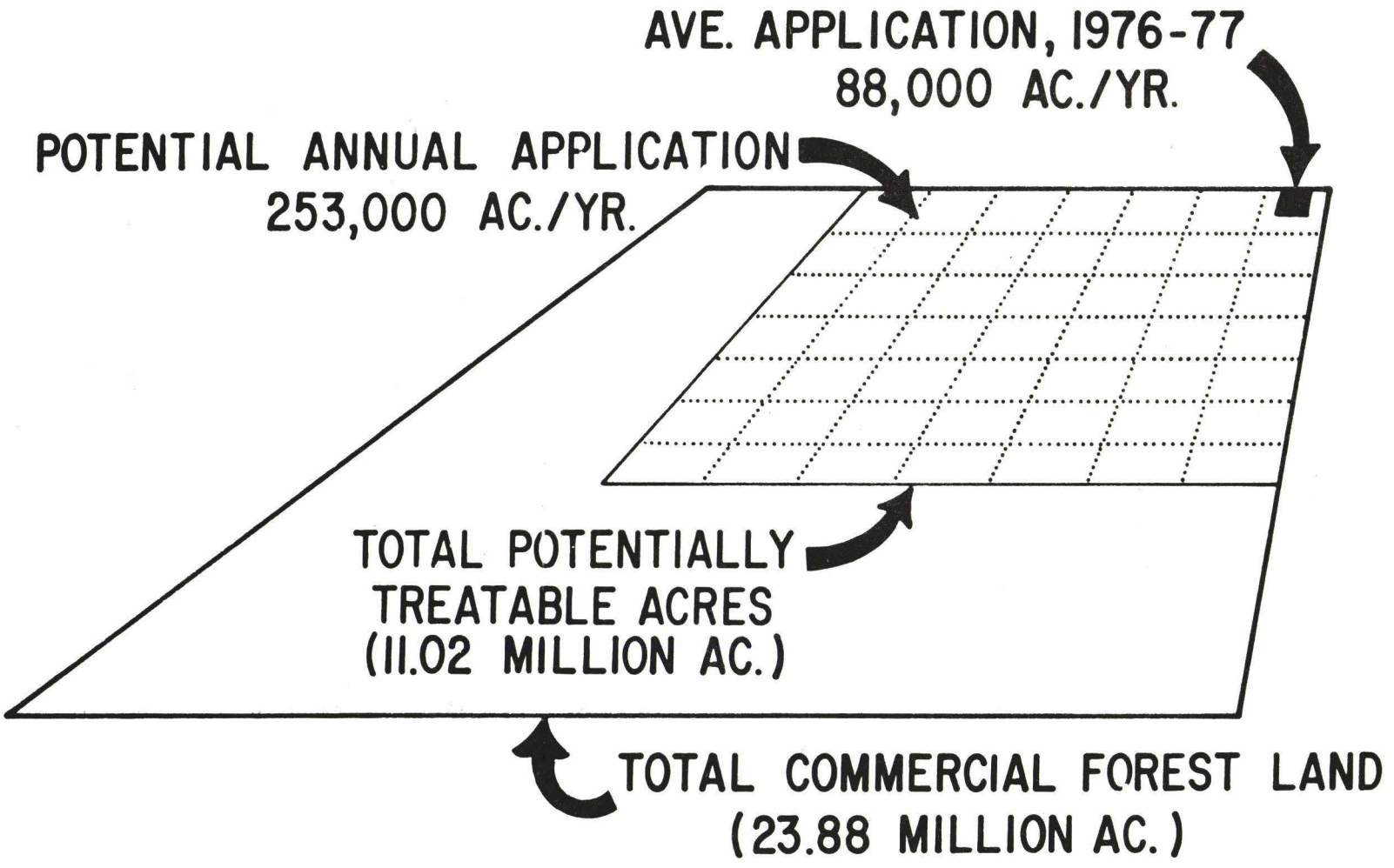

FIGURE C-1 HERBICIDE APPLICATION ON COMMERCIAL FOREST LAND IN OREGON.